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Livestock ownership, commercial off-take rates and their determinants in Ethiopia

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Executive summary

Background

One of the major challenges facing the meat export abattoirs in Ethiopia has been the inadequate supply of quality live animals for meat processing. It has been observed that the live animal throughput is inadequate and, as a result, the existing meat processing facilities operate at less than 50% of their operational capacities. This has increased the fixed costs of operation thereby decreasing the export abattoirs competitiveness in the domestic and export markets. Overcoming the constraint of supply shortage of quality live animals requires, among other things, understanding the livestock producers' ownership patterns and marketing behaviour. This study is conducted with the main objective to assess the current commercial off-take rates for cattle and shoats in the highland and pastoral areas of Ethiopia. Both descriptive and econometric analyses are made using secondary data obtained from different sources for different years covering the highlands and pastoral areas of Ethiopia.

Major findings

In general, very low net commercial off-take rate is observed over different time periods for both cattle and shoats for smallholder farmers and pastoralists in Ethiopia. In 1999/2000, the average net commercial off-take rate of cattle, sheep and goats for smallholder farmers in the highland areas of Amhara, Oromia and Tigray is 8, 22 and 18%, respectively. In 2004/05, the average net commercial off-take rate of cattle, sheep and goats for smallholder farmers in highland and lowland areas of Ethiopia is 7, 7 and 8%, respectively. It is also observed that not only the net commercial off-take rates are considerably low, but also the bulk of this net commercial off-take is of low quality cattle such as culled animals. For example, in 1999/2000, in the highlands of Tigray, Amhara and Oromia regions, old draught oxen accounted for about 75% of the net commercial off-take rate for cattle. In the case of Borana pastoral production system, the average net commercial off-take rate of cattle, sheep and goats for the three year period (2003–05) for cattle, sheep and goats is 9, 6 and 7%, respectively. Most of the off-take assessments are made on quantitative basis due to data limitations and in the future there is a need to determine the off-take rates by different quality dimensions (e.g. by age and weight of live animals).

The observed patterns of livestock ownership and the size of holdings indicate that even though there is presumably large livestock population in Ethiopia the size of livestock holdings at the household level is very small and does not support stable and sufficient commercial off-take. It is observed that about 80% of the smallholder farmers in Ethiopia own cattle while only about 31–38% and 21–33% of them own sheep and goats, respectively.

In the case of Borana pastoralists, about 78, 42 and 20% of them own cattle, goats and sheep, respectively. In terms of the herd size, it is observed that smallholder farmers own only few heads (usually less than or equal to three) of cattle and shoats while the pastoralists own relatively larger number of cattle and shoats. On average, the pastoralists own about 13, 5 and 2 heads of cattle, goats and sheep, respectively. In general, it is observed that smallholder farmers' and pastoralists' livestock holdings are barely self sustaining.

In terms of sex composition, about 46% of the cattle owned are male and 54% are female. If we consider classes of cattle owned, oxen and cows account for about 44 and 24% of the cattle herd, while bulls and young animals like heifers and calves altogether account for about 32% only. The higher proportions of oxen indicate that the main purpose of keeping cattle in the highland areas of Ethiopia is for draught purpose. The majority (66%) of the cattle herd kept by the smallholder farmers are aged 3 to 10 years, while about 16% of cattle are aged 1 to 3 years and about 3% are aged over 10 years. There are four main purposes for keeping cattle aged 3 to 10 years: about 39% of the households keep 3 to 10 years old cattle for draught purpose while 28 and 27% of the households keep cattle for breeding and dairy production purposes, respectively. However, it is interesting to note that only about 1% of the households gave beef production as the main reason for keeping 3 to 10 years old cattle. This indicates that there are limited on-farm cattle fattening operation by the smallholder farmers in the mixed crop–livestock production systems.

The analyses of herd and flock dynamics indicate that the critical importance of reproduction rates of cattle and shoats owned by the farm households and pastoralists are for herd and flocks growth and maintenance since they generally rely less on the market to build herd and flocks. For the sample farm households in the predominantly crop–livestock systems in the highland areas, births and purchases account for 59 and 37% of cattle inflows, respectively. This highlights the importance of reproduction rates of cattle and shoats owned by the farm households and pastoralists for herd and flocks growth and maintenance since they generally rely less on the market to build herd and flocks. On the other hand, there are five components of cattle outflows: deaths, sales, slaughters, gifts and thefts. The deaths and sales are the major components of cattle outflows. In the highland areas of the three regions of Ethiopia, death and sales account for 36 and 50% of cattle outflows, respectively. The size of on-farm cattle slaughters, thefts and gifts are found to be very minimal. It is observed that there is low birth rate and high mortality rate for both cattle and shoats indicating very low herd and flock productivities. Thus, the major reason for low commercial off-take could be low fertility, high mortality and poor nutrition/weight gain. Given the low herd and flocks productivity, the small herd/flock size does not provide a sustainable base for commercial supply of quality live animals. These indicate the potential of increasing commercial off-take of cattle by reducing cattle mortality and increasing the fertility rate. These require changes in

the livestock production, extension and marketing systems. Similar herd and flock dynamics were also observed for Borana pastoralists.

*Many smallholder farmers and pastoralists do not participate in the livestock market. Furthermore, for those smallholder farmers and pastoralists who participate in the market, the size of transaction (sale or purchase of cattle or shoats) is found to be very small***.** For example**,** in 1999/2000, about 61% of the smallholder farmers in the highland areas of Amhara, Oromia and Tigray neither sold nor bought cattle while only 23% sold cattle. In the case of shoats, about 49 and 55% of the smallholder farmers neither sold nor bought sheep and goats, respectively. The CSA data for 2004/05 also indicated that about half of the households neither sold nor bought cattle while 43 and 50% of the smallholder farmers neither sold nor bought sheep and goats, respectively. The main purpose of keeping cattle in the highland areas of Ethiopia is for draught purpose. It is observed that about 47, 72 and 66% of Borana pastoralists neither sold nor bought cattle, sheep and goats, respectively during the period from 2003 to 2005.

*It is observed that there are significant off-takes of cattle and shoats for national consumption***.** For example, the off-take rate for cattle, sheep and goats for national consumption in 2005/06 is 3, 13 and 10%, respectively. Thus, national consumption absorbs a large share of the already observed overall low net commercial off-take rates or market supply from smallholder farmers and pastoralists leaving a small share of marketed supply for the live animal and meat export activities. Significant livestock transaction takes place among the livestock producers themselves for breeding, replacement and draught purpose. In the short run, there might be some degree of market segmentation regarding the demand for live animals for domestic and export markets due to different quality requirements in the domestic and export markets, e.g. domestic consumers demand animals of all age, sex, breed and body conditions but export abattoirs need animals with specific high quality attributes to meet importers' requirements. However, in the long run, with growing domestic supermarkets and increased demand for high quality meat, the demand for high quality live animals for domestic consumption is expected to increase, which increases the competitive pressure on export abattoirs.

*Herd/flock size and land holdings are found to be the key factors determining smallholder farmers' choices to participate in the market***.** Herd size is positively associated with household's choice of participation in cattle market as a seller only and both as a seller and buyer. That is, the probability of the household's participation in cattle market as a seller only or both as seller and buyer increases with herd size while the probability of non-participation in cattle market decreases as the herd size increases. Thus, the smallholders' market participation and hence market off-take has been limited because they have low herd size.

Then, the important question is how to increase the herd size owned by smallholder farmers in order to increase their market participation. There is negative effect of land holding on the household decision to participate in cattle market as a seller only while it has positive effect on household decision to participate in cattle market as a buyer only. That is, as the size of land holdings increases, the probability that the household participate in cattle market as a seller only decreases while the probability that the household participates in cattle market as a buyer only increases.

Conclusion and policy implications

It is observed that there are very low commercial off-take rates of cattle and shoats for smallholder farmers and pastoralists in Ethiopia. Furthermore, a large proportion of the few animals sold are also of such age and body conditions that many of them are unlikely to meet the needs of meat export abattoirs. One of the reasons for the low commercial off-take rate and limited market participation could be small herd and flock sizes accompanied by very low fertility and/or high mortality rates. The implication of limited market participation is that under the current production and marketing conditions, small-scale farmers and pastoral livestock production systems do not provide regular and adequate market supply of quality live animals at competitive prices, which adversely affects the efficient utilization of meat processing capacity of export abattoirs and hence their competitiveness in the domestic and export markets.

Options for strategic interventions

Improve the extension messages and functions. Extension messages should be designed to advise livestock producers that will result in improved productivity (increased fertility, reduced mortality, improved feed conversion ratio), quality of marketed animals (sell at optimal age, weight and body condition), and market orientation of smallholder producers so that they make purchase and sale decisions to maximize household returns. There is also a need to disseminate appropriate technologies for better feeding and health management practices, which will significantly increase the quantity and quality of off-take.

Public sector extension alone may not be able to achieve the above objectives to change producer behaviour to increase supply. Since abattoirs are interested in the regular supply of better quality animals by smallholders and pastoralists, they should be active partners in this strategy. Currently there is inadequate information on the extent of supply hinterlands that abattoirs use to procure animals, whether they offer competitive prices for similar animals demanded by alternative buyers such as formal and informal live animal exporters and domestic market traders, whether they use all possible purchase mechanisms or options to

collect animals from different supply hinterlands especially areas not easily accessible either because of poor road connection or due to other risks associated with marketing. A detailed analysis of the current functioning and efficiency of the livestock supply chains and abattoirs' procurement policies and mechanisms will be required to identify entry points for the abattoirs to choose specific interventions from possible options and to recommend effective supply relationship.

*Investment in animal health services is required to improve the productivities of smallholder farmers and pastoralists***.** From the supply side, the large numbers of non-participants need to enter the market for which improvement in fertility rate and significant reduction in mortality rate will be required so that herd/flocks sizes increase sufficiently to allow smallholders to sell more animals. This requires increased private and public investment in animal health services.

*Encourage the emergence of commercial-oriented livestock production systems such as the development of commercial feedlot operations, improved pastures, small-scale fattening, large-scale ranching, and dairy and beef operations***.** However, the social and economic feasibilities of such commercially oriented production systems need to be carefully evaluated and there is a need to consider how to effectively and efficiently integrate smallholder farmers and pastoralists to the high value domestic and export markets value chains for live animals and meat through the development of appropriate institutions, policies and marketing infrastructure and support services.

Build a sustainable and demand-driven market data collection and information service that provides timely, accurate, reliable, secured, and affordable production and market information to different target beneficiaries. There is lack of reliable baseline data to monitor and assess the changes in the livestock production and marketing environments in Ethiopia. There is also lack of historical and current livestock production and marketing related statistics to support the business and policy decision making in the livestock subsector.

1 Introduction

1.1 Background

Recently, several large scale meat processing abattoirs have been established in Ethiopia in response to the emerging meat export opportunities to the Middle East and north African countries. There are also several meat export abattoirs under construction and more are planned to be established in the near future in different regions of the country. These developments are in the right direction toward diversifying and increasing Ethiopia's foreign exchange earnings and improving the livelihoods of livestock producers and other actors engaged in the livestock related activities.

One of the major challenges facing the meat export abattoirs has been that the competitiveness of these firms in the domestic and export markets has been limited by the underutilization of their meat processing capacities. It has been observed that the live animal throughput is inadequate and, as a result, the existing meat processing facilities operate at less than 50% of their operational capacities. This is apparently due to inadequate supply of the required quality live animals for meat processing by the export abattoirs. Export abattoirs are competing with the demand for live animals for domestic consumption, and for formal and informal (cross-border) trade.

The key problem is that when the meat processing abattoirs are not operating at their optimum capacity they are not minimizing their costs of operations and they are facing cost disadvantage, which makes them less competitive in the domestic and international meat markets. Meat export abattoirs are also required to ensure a consistent and continuous supply of meat in order to meet the demand of the customers in the importing countries. Thus, there is an urgent need to devise alternative strategies to ensure adequate market supply of quality live animals to meet export abattoirs processing needs in order to improve their efficiency and competitiveness.

The first step towards improving the market supply of quality live animals is to understand the livestock producers' ownership patterns and marketing behaviour and factors affecting them. There is a need to assess whether and how the existing small-scale and pastoral livestock production systems can provide sustainable and adequate live animal supply, which can meet the demand for domestic consumption and for export markets. Such information provides useful insights towards the designing and implementation of strategies to alleviate the shortages of quality live animal supplies in the market. However, this type of information is currently unavailable or inadequate at best.

1.2 Objectives of the study

The main objective of this study is to assess the commercial off-take rates for cattle and shoats in the highland and pastoral areas of Ethiopia in order to complement the limited empirical information related to the off-take rates. The specific objectives are: (a) estimate off-take rates for cattle and shoats in mixed crop–livestock systems in the predominantly highland regions and in the pastoral systems in the lowlands, (b) estimate extent and nature of market participation by households and identify factors affecting the nature and extent of market participation for live animals in mixed crop–livestock systems, (c) quantify the extent of demand for cattle and shoats for domestic consumption to assess how much of the aggregate commercial off-take is absorbed by domestic consumption and the balance left for live animal and meat export.

The remaining sections of this paper are organized as follows. Section Two discusses the conceptual framework and empirical model for this study. The data sources and descriptions are given in Section Three. In Section Four the results and discussions of the descriptive and econometric analyses are presented. Finally, conclusions and recommendations are made in Section Five.

2 Conceptual framework and empirical model

The main reason for calculating the off-take rates is to estimate the size of live animal supply to the market. In specialized commercial herds animals are raised for disposal and off-take is usually defined as a percentage of sale or slaughter at the end or during a production cycle to the initial stock. In smallholder mixed farming systems and also in pastoral systems, animals are kept for multiple functions, and sale or other forms of disposal are not regular phenomenon; rather sales are sporadic based on immediate cash needs. In this regard, one of the key questions to ask is: what proportion of the live animals from such herds will leave the livestock herders for off-farm slaughter or export or other kind of uses? In the literature, different methods are used in computing off-take rates for smallholder mixed farms and pastoral systems (see for example, Sutter 1987; Bouwman 2005). Sutter (1987) computed off-take rate as the total number of animals sold, slaughtered and disposed of for non-market transaction over a given period divided by total herd size. Bouwman et al. (2005) calculated off-take rate as the fraction of the animal population that is taken out in a given year for slaughter.

In this study, two types of off-takes are estimated for cattle and shoats produced under smallholder mixed farming and under pastoral systems. First, the gross commercial off-take rate, which is given as the total sales as a percentage of the average stock of a household is computed as:

$$Gross\ Commercial\ Offtake\ Rate = \left(\frac{Sales}{0.5(Opening\ Stock + Ending\ Stock)} \right) * 100$$

The denominator is the average stock, which is computed as a half of the sum of opening stock and ending stock over one year period. The gross commercial off-take involves animal sales and excludes other outgoings and incomings such as transfers, exchanges, gifts and purchases. Slaughters, gifts and exchanges are on-farm while the sale of animals could be to others or just among livestock owners. Some transactions like buying and selling of animals for herd replacement, breeding and draught use do not lead to a net transfer of animals from the farming community though for an individual household these constitute net transfer. When the interest is in the number of livestock that actually leaves the livestock owners and enter the market for slaughter, other exchanges such as on-farm transfers, on-farm exchanges and on-farm slaughters need to be netted out for off-take computations. Thus, from the point of view of assessing the supply of live animals by the households to the market, net commercial off-take rather than gross commercial off-take is a more relevant parameter to be estimated. As a result we have also estimated the net commercial off-take rate, which is given

as the sales minus purchases made by the households as a percentage of the average stock. Thus, the net commercial off-take rate is given as follows:

$$Net\ Commercial\ Offtake\ Rate = \left(\frac{Sales - Purchases}{0.5(Opening\ Stock + Ending\ Stock)} \right) * 100$$

The net commercial off-take could be negative for net buyers, zero for those whose sales and purchases are equal or for those who are not engaged in the market, and it is positive for net sellers. In general, the livestock producers can buy and/or sell cattle and/or shoats. Based on the various combinations of sales and purchases transactions in which the livestock producers might be engaged, there are four mutually exclusive and exhaustive market participation regimes or categories to which one livestock producer can belong: those who only sell; those who only buy; those who both sell and buy; and those who neither sell nor buy. Once the grouping of farm households into different market participation regime is made, the next important empirical issue related to the supply of live animals to the market is to investigate what factors affect a farm household's choice of a given market participation regime. For example, what factors increase a farm household's likelihood to be a seller, buyer, or both a seller and a buyer? The farm households' choice of market participation regimes discussed here are examples of unordered discrete type choices. In such situations, the factors influencing the household's discrete choice behaviour among different alternatives is usually modelled either using a multinomial logit model or multinomial probit model.

The multinomial logit model is derived from random utility function (McFadden 1973). In random utility model, it is assumed that individuals maximize their utility by choosing one of the alternatives. In our case, it is assumed that the livestock producers maximize their utility by choosing one among the four mutually exclusive market participation regimes. One of the critical assumptions of the multinomial logit model is the independence of irrelevant alternatives (IIA), which means that the odds are independent from the other outcomes available (Wooldridge 2002). However, in the case of multinomial probit model the IIA is not assumed, the disturbance terms are correlated and normally distributed. In general, it is argued that the IIA holds if the outcomes are distinct and it does not hold if the outcomes are close substitutes.

The multinomial logit model allows the estimation of a set of probabilities of four market participation regimes for households with a given characteristics. The effects of the independent variables are allowed to differ for each outcome as opposed to ordered probit model where only one coefficient is estimated for all the outcomes. The detailed discussions of multinomial logit model are given in Greene (1993), Long (1997) and Wooldridge (2002). The specification of multinomial logit model is given in Appendix 2.

3 Data sources and descriptions

In this study secondary data from different census and sample surveys of households were used. The contents, area coverage, sampling frame and design, and data formats varied among the datasets obtained. The following sections provide the descriptions of the individual datasets used in this study. The strengths and weaknesses of the various data sources are summarized in Appendix 1.

ILRI/IFPRI sample household survey, 1999–2000

A subset of data from sample survey of households conducted during 1999–2000 by the International Livestock Research Institute and the International Food Policy Research Institute (ILRI/IFPRI) under the project on sustainable land management policies in the highlands of Ethiopia is used to estimate different off-take rates for cattle and shoats and to conduct the econometric analyses of farm household's cattle and shoats marketing behaviour. This survey involved 1054 sample households from the highland areas of three regions in Ethiopia: 500 households in Tigray, 434 households in Amhara and 120 households in Oromia. The sampling design used was multistage stratified random sampling whereby all highland *woredas* were first classified on the basis of a combination of population density (high vs. low), agricultural potential (high vs. low) and market access (high vs. low). Then sample of *woredas* representing each of the possible domains based on the above classification were selected. From the selected *woredas*, sample peasant associations (PAs) or villages were selected for community level surveys. From the selected peasant associations, sample households were selected randomly for household and plot level surveys.

The dataset from this survey contains detailed data on socioeconomic and household characteristics for the surveyed households and detailed information on marketing behaviour on most recent completed livestock marketing transactions. In addition, the dataset contains inventory of livestock species taken over one year period, which allows the analyses of herd and flock dynamics for that particular reference period. The inventory data was collected by requesting the households to recall livestock transactions and inventory changes over the last one year period at the time of the survey.

The livestock inventory data includes the opening stock at the beginning of the year along with incoming and outgoing animals over one year period. The incoming includes births, purchases and gifts received while outgoing includes deaths, sales, slaughters and giving out. The dataset allows the estimation of different types of off-takes from the herd and flocks. The off-takes could be due to death, sales, slaughter, or giving out. The ending stock is obtained by adding the incoming to opening stock and then subtracting the outgoing.

CSA sample survey of livestock producers, 2004–05

The dataset from the agricultural sample survey of livestock producers in 2004/05, which covered the rural and urban agricultural population in all regions of the country except all zones of Gambella Region, and non-sedentary population of three zones of Afar and six zones of Somali regions is used. The survey involved 334,972 and 123,585 rural and urban households, respectively. This dataset contains the total number of each type of livestock as well as the numbers disaggregated by breed, age, sex and purpose of keeping livestock by households on the reference date of November 10, 2005. Livestock inventory data were also taken over the reference period of November 11, 2004 to November 10, 2005. The inventory data includes estimated number of births, purchases and acquired animals during the reference period. The inventory data also include number of sales, slaughters, deaths and offerings. This dataset allows the estimation of livestock population and different off-take rates by zones and regions and has larger sample size and wider geographic coverage than the ILRI/IFPRI dataset. However, this dataset does not contain socioeconomic variables to allow the econometric analysis of factors affecting the marketing behaviour of households in different regions of the country. As a result this dataset is used only for the descriptive analysis.

CSA sample survey on household income and expenditure, 1999–2000

The subset of national household income, consumption and expenditure survey data conducted by CSA in 1999/2000 is used to indirectly estimate the demand for live animals for domestic consumption. This sample survey covered 8660 rural and 8672 urban households in the sedentary areas of the country excluding the non-sedentary population in Afar and Somali regional states.

GL-CRSP survey of pastoral households, 2003–05

Repeat-visit survey or panel data collected on a quarterly basis for three years period (2003, 2004 and 2005) is obtained for Borana pastoral area in Ethiopia from the Global Livestock Collaborative Research Support Program (GL-CRSP) project. The sample of pastoral households included in this study was 151, 150 and 150 for 2003, 2004 and 2005, respectively. The panel involved same households every year. This dataset contains similar inventory data to that of ILRI/IFPRI dataset and was collected over three years. However, unlike the ILRI/IFPRI dataset, this dataset does not contain sufficient variables in order to conduct the econometric analysis of the marketing behaviour of pastoralists. As a result, this dataset is used just for the estimation of the various off-take rates for the study areas for three years.

4 Results and discussions

This section presents the results of descriptive and econometric analyses using secondary data from different sources. The empirical results are expected to inform the discussions regarding whether the existing small-scale and pastoral livestock production systems can provide sustainable and adequate live animal supply to meet the current demand for live animals for domestic consumption and export markets. Furthermore, these results also help to gauge to what extent the current public and private sectors efforts of establishing more export abattoirs should be promoted under the status quo livestock production and marketing systems in Ethiopia.

4.1 Results of the descriptive analysis

Gross and net commercial off-take rates

The summary of gross and net commercial off-take rates estimates for cattle and shoats are given in Table 1. The gross commercial off-take rate is obtained by dividing the total sales of live animals over one year period by the annual average stock. The average stock is obtained by taking the sum of opening and ending balances and dividing by two. The gross commercial off-take rate does not take into account the purchases made by livestock producers. On the other hand, net commercial off-take rate is obtained by dividing the net sales of animals (total sales minus total purchases) over one year period by the annual average stock. The net commercial off-take rate takes into account the purchases made by livestock producers. In general, very low commercial off-take rate is observed over different time periods for both cattle and shoats for smallholder farmers and pastoralists. For example, in 1999/2000, the average net commercial off-take rate of cattle, sheep and goats for smallholder farmers in highland areas of Amhara, Oromia and Tigray is 8, 22 and 18%, respectively. In 2004/05, the average net commercial off-take rate of cattle, sheep and goats for smallholder farmers in highland and lowland sedentary areas of Ethiopia is 7, 7 and 8%, respectively. There are also low gross and net commercial off-take rates of cattle, sheep and goats from pastoral production system. For example, the three years (2003–05) average net commercial off-take rate of cattle, sheep and goats is 9, 6 and 7%, respectively. The difference between gross and net commercial off-take rates is observed to be the lowest for Borana pastoral production system. This shows that there is limited purchase of live animals by Borana pastoralists. On the other hand, there are large differences between gross and net commercial off-take rates for the highland areas of the three regions and for all regions of Ethiopia, which show the importance of both sale and purchase activities by livestock producers.

Table 1. *Cattle and shoats gross and net commercial off-take rates by different years and sources of data*

Data source	Reference year	Sample sizes	Annual gross commercial off-take rates (%)			Annual net commercial off-take rates (%)		
			Cattle	Sheep	Goats	Cattle	Sheep	Goats
ILRI–IFPRI[a]	1999–2000	1054	16 (37)	34 (56)	30 (58)	8 (42)	22 (71)	18 (78)
CSA[b]	2004–05	458,557	17 (50)	19 (68)	15 (31)	7 (40)	7 (41)	8 (34)
GL-CRSP[c]	2003–05	451	11 (34)	10 (43)	11 (44)	9 (34)	6 (44)	7 (50)

a. Includes highland areas of Amhara, Oromia and Tigray regions.
b. Excludes pastoral livestock.
c. Includes Borana pastoral area only.
Figures in parentheses are standard deviations.

The sex compositions of the net commercial off-take rates for cattle and shoats for 2004/05 are given in Table 2. For cattle about half of the net commercial off-take rate involves male animals for all production systems. However, for shoats more than 70% of the net commercial off-take rates are in terms of males in the case of smallholder farmers in highland and lowland and sedentary areas of Ethiopia. For Borana pastoral production system, the net commercial off-take rate is totally in terms of male shoats.

Table 2. *Composition of household annual gross and net commercial market off-take rates by sex of cattle and shoats in Ethiopia, 2004/05*

Classes of animals	Annual gross commercial off-take rates (%)			Annual net commercial off-take rates (%)		
Smallholder farmers[1]	Male	Female	All	Male	Female	All
Cattle	10 (42)	7 (25)	17 (50)	4 (29)	3 (27)	7 (40)
Sheep	10 (32)	9 (50)	19 (68)	5 (26)	2 (28)	7 (41)
Goats	8 (18)	7 (21)	15 (31)	6 (20)	2 (25)	8 (34)
Pastoralists[2]						
Cattle	6 (18)	5 (22)	11 (34)	5 (17)	4 (23)	9 (34)
Sheep	6 (27)	4 (18)	10 (43)	6 (27)	0 (23)	6 (44)
Goats	7 (35)	4 (17)	11 (44)	7 (35)	0 (27)	7 (50)

1. Based on CSA dataset.
2. Based on GL-CRSP dataset.
Figures in parentheses are standard deviations.

The composition of household's annual gross and net commercial off-take rates by classes of cattle and shoats in the highland areas of the three regions of Ethiopia are given in Tables 3 and 4, respectively. In the case of cattle, it is observed that not only is the net commercial off-take rate considerably low, but also that the bulk of this net commercial off-take is of low quality cattle such as culled draught oxen. For example, oxen accounted for about 62 and 75% of the gross and net commercial off-take rate for cattle, respectively. Next to oxen, bulls account for significant proportion (25%) of annual net commercial off-take rate. The annual net commercial market off-take rates for calves and heifers are found to be negligible. Thus,

cattle sale can be considered as a by-product of crop production in the mixed crop–livestock production systems of Ethiopia. The estimated off-take rates, especially for sheep and goats appear to be lower than some of the earlier estimates and conventional wisdom prevailing in the country. For example, Belachew and Jemberu (2003) estimated annual off-take at 10% for cattle, 35% for sheep and 38% for goats nationally.

Table 3. *Composition of household annual gross commercial off-take rates by classes of cattle and shoats in the highland areas of the three regions of Ethiopia*

Animal species	Amhara	Oromia	Tigray	Mean
Cattle (%)				
Oxen	11 (31)	9 (27)	9 (35)	10 (32)
Cows	3 (13)	4 (10)	3 (19)	3 (15)
Bulls	1 (6)	1 (4)	1 (10)	1 (8)
Heifers	1 (7)	1 (4)	1 (4)	1 (6)
Calves	1 (7)	0 (2)	0 (3)	1 (5)
All groups	17 (36)	15 (30)	14 (40)	16 (37)
Shoats (%)				
Sheep	37 (58)	34 (56)	30 (53)	34 (56)
Goats	37 (69)	24 (47)	27 (50)	30 (58)
All groups	37 (58)	30 (50)	32 (53)	34 (55)

Note: Figures in parentheses are standard deviations.
Source: Prepared based on ILRI/IFPRI (1999–2000).

Table 4. *Composition of household annual net commercial market off-take rates of cattle and shoats in the highland areas of the three regions of Ethiopia*

Animal species	Amhara	Oromia	Tigray	Mean
Cattle (%)				
Oxen	6 (34)	2 (28)	8 (35)	6 (4)
Cows	1 (7)	0 (8)	–1 (18)	0 (14)
Bulls	1 (15)	3 (12)	3 (19)	2 (17)
Heifers	1 (14)	1 (5)	–1 (13)	0 (13)
Calves	0 (8)	0 (2)	0 (4)	0 (6)
All groups	9 (41)	6 (29)	9 (46)	8 (42)
Shoats (%)				
Sheep	29 (70)	20 (65)	13 (75)	22 (71)
Goats	24 (93)	21 (54)	17 (66)	18 (78)
All Groups	27 (75)	18 (60)	20 (70)	23 (71)

Note: Figures in parentheses are standard deviations.
Source: Prepared based on ILRI/IFPRI (1999–2000).

From the various datasets available to us, it was not possible to determine the off-take rates in terms of age, weight and time of the sale. However, the study by Ayele et al. (2006) based on a survey of over 2500 animal transactions in 9 small ruminant markets in eastern Ethiopia indicated that about half of the shoats are marketed at the age of 15 or less than 15 months.

Ayele et al. (2006) also indicated that about 57 and 55% of the sheep and goats marketed had good body condition while the remainder had poor body condition at the time of sale. In terms of the time of selling, there is also seasonality in supply of live animals due to different reasons. There are strong peaks and troughs of producer sales of animals at different times in different locations. These strong spatial and seasonal dimensions are induced by various factors, e.g. cash need, drought, feed shortage and festivals.

Patterns of ownership

The summary statistics of cattle and shoats ownership based on different datasets are given in Table 5. The observed patterns of livestock ownership and the size of holdings indicate that, even though there is presumably large livestock population in Ethiopia, the size of livestock holdings at the household level is very small. The majority of the smallholder farmers own cattle but the average herd and flock sizes are quite small. For example, it is observed that about 80–83% of the smallholder farmers in Ethiopia own cattle while only about 31–38% and 21–33% of them own sheep and goats, respectively. The average size of cattle for smallholder farmers is four.

Table 5. *Frequency distribution of livestock producers according to cattle and shoats ownership in Ethiopia, various years*

Number owned	Smallholder farmers[1]			Smallholder farmers[2]			Borana pastoralists[3]		
	Cattle	Sheep	Goats	Cattle	Sheep	Goats	Cattle	Sheep	Goats
0	17	69	79	20	62	67	22	80	58
1	13	3	2	11	6	4	2	2	2
2	14	4	4	15	8	6	4	2	2
3	12	4	2	14	6	4	3	2	4
≥4	44	20	14	40	18	19	69	14	34
Mean (SD)	3.7 (3.6)	2.1 (5.1)	1.5 (4.0)	3.7 (4.7)	1.9 (4.4)	2.2 (6.1)	13.1 (17.5)	2.2 (7.4)	4.7 (8.3)
Max	30	50	57	145	170	160	120	79	43
Male (%)	NA	NA	NA	46	24	27	NA	NA	NA

1. Prepared based on ILRI/IFPRI (1999–2000).
2. Prepared based on CSA (2006).
3. Prepared based on GL-CRSP (2006).
Figures in parentheses are standard deviations and the minimum size of cattle and shoats owned was zero in all cases. NA denotes data not available.

In the case of Borana pastoralists, about 78, 42 and 20% of them own cattle, goats and sheep, respectively. In terms of the size of holdings, it is observed that smallholder farmers own only few heads of live animals (usually less than or equal to four heads of cattle and less or equal to three heads of sheep or goats) while the Borana pastoralists own relatively larger number of cattle and shoats. On average, the Borana pastoralists own about 13, 5 and 2 heads of cattle, goats and sheep, respectively. One of the key factors limiting the number

of cattle owned by the household in the highland areas is the size of land holdings. It is observed that there is very strong and positive relationship between cattle herd size and the size of land holdings.

Livestock producers keep almost equal proportion of male and female cattle while significantly lower proportion of male sheep and goats compared to females (Table 5). For example, it is observed that about 46% of the cattle owned by smallholder farmers are male and 54% are female. However, the proportion of male sheep and goats are 24 and 27%, respectively. As opposed to cattle, fewer male sheep and goats are kept on-farm. This is may be because males are either sold in the market or consumed at home while females are kept for breeding purpose.

In terms of the class composition of cattle owned, oxen and cows account for about 44 and 24% of the cattle herd while bulls and young animals like heifers and calves altogether account only for about 32% (Table 6). The higher proportions of oxen indicate that the main purpose of keeping cattle in the highland areas of Ethiopia is for draught purpose. This result confirms the results of other several micro-level studies on the role of livestock in smallholder crop–livestock systems (see for example, Gryseels 1988; Asamenew 1991; Sansoucy et al. 1995).

Table 6. *Composition of cattle and shoats owned by households in the highland areas of the three regions of Ethiopia, 1999–2000*

Composition	Amhara	Oromia	Tigray	All regions
Mean cattle owned	3.5 (3.6)	5.4 (4.4)	3.6 (3.4)	3.7 (3.6)
Oxen (%)	49 (32)	39 (31)	40 (25)	44 (31)
Cows (%)	23 (21)	27 (20)	25 (22)	24 (21)
Bulls (%)	8 (16)	11 (16)	13 (20)	11 (18)
Heifers (%)	9 (18)	10 (15)	10 (16)	10 (17)
Calves (%)	11 (17)	13 (18)	12 (14)	11 (16)
Mean shoats owned	2.9 (5.0)	2.4 (3.8)	4.5 (8.5)	3.6 (6.9)
Sheep (%)	68 (43)	69 (43)	51 (47)	61 (46)
Goats (%)	32 (43)	31 (43)	49 (47)	39 (46)

Note: Figures in parentheses are standard deviations.
Source: Computed based on ILRI/IFPRI (1999–2000).

It is observed that smallholder farmers keep higher proportion of older animals. For example, the majority (66%) of the cattle herd owned by smallholder farmers are aged 3 to 10 years while about 16% are aged 1 to 3 years and about 5% are aged over 10 years (Table 7). There are four main purposes for keeping cattle aged 3 to 10 years: about 39% of the households keep 3 to 10 years old cattle for draught purpose while 28 and 27% of the households keep for breeding and dairy production purposes, respectively (Table 8). However, it is interesting to note that only about 1% of the households indicated beef production as the main reason for keeping 3 to 10 years old cattle. This indicates that there are limited on-farm cattle

fattening operation by the farm households. In the case of sheep and goats, about 50% or more of smallholder farmers keep two years and older animals (Tables 9 and 10).

Table 7. *Age structure of cattle owned by households by regions in Ethiopia, 2004–05*

Region	Age category (% of cattle)				
	Less than 6 months	6 months to 1 year	1 year to under 3 years	3 to 10 years	Over 10 years
Tigray	8 (13)	5 (12)	13 (18)	69 (25)	5 (14)
Afar	13 (15)	12 (16)	15 (20)	59 (22)	1 (6)
Amhara	6(12)	5 (11)	13 (21)	71 (26)	5 (15)
Oromia	8 (14)	8 (14)	16 (23)	66 (25)	2 (6)
Somali	16 (18)	8 (15)	15 (21)	60 (22)	1 (6)
Benshangul-Gumuz	8 (13)	9 (15)	18 (24)	64 (25)	1 (7)
SNNPR	8 (14)	8 (15)	18 (27)	65 (28)	1 (8)
Harari	11 (17)	9 (18)	23 (30)	56 (29)	1 (6)
Addis Ababa	4 (10)	6 (11)	12 (18)	73 (25)	5 (14)
Dire Dawa	11 (18)	9 (19)	25 (34)	54 (32)	1 (6)
Country	8 (14)	7 (14)	16 (24)	66 (26)	3 (11)

Note: Figures in parentheses are standard deviations.
Source: CSA (2006).

Table 8. *Purposes of keeping cattle aged between 3 and 10 years by regions in Ethiopia*

Region	Purpose of keeping by region (%)				
	Beef	Breeding	Dairy	Draught	Others
Tigray	0 (5)	47 (32)	3 (12)	49 (32)	1 (7)
Afar	1 (7)	32 (33)	56 (37)	9 (22)	2 (8)
Amhara	0 (6)	38 (34)	6 (20)	53 (33)	3 (12)
Oromia	2 (10)	29 (34)	27 (35)	39 (33)	3 (12)
Somali	1 (7)	41 (42)	39 (41)	17 (27)	2 (9)
Benshangul-Gumuz	1 (7)	39 (36)	15 (30)	42 (33)	3 (11)
SNNPR	2 (12)	12 (28)	46 (39)	30 (32)	10 (24)
Harari	4 (17)	34 (44)	39 (45)	16 (29)	7 (23)
Addis Ababa	0 (3)	21 (31)	19 (31)	54 (34)	6 (16)
Dire Dawa	2 (13)	40 (45)	32 (44)	19 (32)	7 (23)
Country	1 (10)	28 (35)	27 (37)	39 (34)	5 (17)

Note: Figures in parentheses are standard deviations.
Source: CSA (2006).

Table 9. *Age structure of sheep owned by households by regions in Ethiopia*

Region	Age category (% of sheep)			
	Less than 6 months	6 months to 1 year	1 to 2 years	2 years and older
Tigray	22 (19)	11 (20)	12 (21)	55 (26)
Afar	21 (20)	14 (19)	15 (23)	50 (27)
Amhara	25 (21)	9 (19)	12 (23)	54 (27)
Oromia	28 (24)	10 (21)	12 (25)	50 (28)
Somali	21 (19)	10(16)	14 (21)	55 (25)
Benshangul-Gumuz	24 (24)	13 (24)	15 (27)	48 (31)
SNNPR	22 (25)	10 (23)	13 (28)	55 (32)
Harari	17 (25)	8 (20)	23 (37)	52 (37)
Addis Ababa	24 (21)	10 (17)	11 (24)	55 (28)
Dire Dawa	21 (21)	13 (25)	17 (29)	49 (30)
Country	24 (23)	10 (21)	13 (25)	53 (29)

Note: Figures in parentheses are standard deviations.
Source: CSA (2006).

Table 10. *Age structure of goats owned by households by regions in Ethiopia*

Region	Age category (% of goats)			
	Less than 6 months	6 months to 1 year	1 to 2 years	2 years and older
Tigray	23 (19)	12 (16)	13 (20)	52 (24)
Afar	21 (17)	14 (19)	14 (19)	51 (25)
Amhara	25 (23)	11 (21)	13 (24)	51 (28)
Oromia	26(23)	12 (22)	13 (25)	49 (28)
Somali	22 (17)	11 (15)	13 (20)	54 (23)
Benshangul-Gumuz	29 (24)	14 (22)	14 (23)	43 (27)
SNNPR	23 (25)	12 (24)	13 (27)	52 (31)
Harari	26 (25)	12 (19)	15 (25)	47 (24)
Addis Ababa	30 (25)	13 (23)	8 (18)	49 (26)
Dire Dawa	23 (19)	12 (19)	14 (22)	51 (25)
Country	25 (23)	12 (21)	13 (24)	50 (28)

Note: Figures in parentheses are standard deviations.
Source: CSA (2006).

Herd/flock dynamics

Analysis of herd and flock dynamics allows us to see to what extent the herd/flock structures are stable over a given year. The dynamics of smallholder farmers' and pastoralists' cattle herds and shoats flocks are analysed in terms of the major sources of cattle and shoats inflows and outflows over one year period and the results are presented in Tables 11–13. For smallholder farmers, it is observed that animal births are more important than purchases from the market in building and maintaining the size of cattle herd. For example, births

and purchases account for 59 to 72% and 24 to 37% of cattle inflows. This highlights the importance of reproduction rates of cattle owned by the farm households for cattle herd growth and maintenance since they generally rely less on the market to build herd. Cattle birth is even more important in the case of pastoralists in that it accounts for about 92% of cattle inflows. However, it is argued that markets are not commonly used for restocking by larger pastoral households but poor households rely more heavily on purchases for restocking (Barrett et al. 2004). The proportion of gifts in the cattle inflows is the same for smallholder farmers and pastoralists. Borrowing and exchange are insignificant in all cases.

Table 11. *Cattle herd dynamics[1] under different production systems in Ethiopia*

Herd parameter	Smallholder farmers		Pastoralists
	ILRI/IFPRI data	CSA data	GL-CRSP data
Opening stock (number)	3.7 (3.6)	4.5 (5.1)	13.1 (17.5)
Incoming (number)	0.6 (1.1)	1.6 (2.2)	3.2 (4.7)
Births (%)	59 (47)	72 (40)	92 (20)
Purchases (%)	37 (46)	24 (38)	3 (12)
Gifts (%)	4 (18)	4 (17)	4 (15)
Outgoing (number)	0.8 (1.6)	1.1 (2.4)	1.5 (2.5)
Deaths (%)	36 (43)	42 (45)	25 (36)
Sales (%)	53 (45)	50 (46)	66 (38)
On-farm slaughter (%)	5 (20)	4 (17)	2 (10)
Given out (%)	5 (20)	4 (18)	5 (15)
Stolen (%)	1 (6)	NA	0 (8)
Ending stock (number)	3.5 (3.5	4.9 (5.3)	14.9 (19.9)
Average stock (number)	3.6 (3.5)	5.1 (5.1)	14.0 (18.6)
Change in inventory (%)	–4 (42)	19 (57)	13 (30)
Birth rate (%)[2]	3 (12)	NA	35 (38)
Death rate (%)[3]	10 (34)	14 (34)	11 (65)

1. Herd dynamics is analysed over one year period and the figures in parentheses are standard deviations.
2. Birth rate is computed as a ratio of the number of calves born to the number of cows at the beginning of the year.
3. Death rate is calculated as the ratio of the number of cattle deaths to the average cattle stock.
Source: Prepared based on ILRI/IFPRI (1999–2000) and CSA (2006).

On the other hand, there are five components of cattle outflows: deaths, sales, slaughters, gifts and thefts. Sales and deaths are the major components of cattle outflows. Cattle sale accounts for about 50% or more of cattle outflows for smallholder farmers and pastoralists. Cattle death accounts for 36 to 42% of cattle outflows for smallholder farmers while for pastoralists it accounts for about 25% of cattle outflows. The size of on-farm cattle slaughters, thefts and gifts are found to be very minimal. It is observed that there is low birth rate and high mortality rate for cattle for smallholder farmers indicating very low herd productivity. These indicate the potential of increasing commercial off-take of cattle by reducing cattle mortality and/or increasing the fertility rate, which require changes in the livestock production, extension and marketing systems.

Table 12. *Sheep flocks dynamics[1] under different production systems in Ethiopia*

Flock parameter	Smallholder farmers		Pastoralists
	ILRI/IFPRI data	CSA data	GL-CRSP data
Opening stock (number)	2.1 (5.1)	4.4 (6.3)	2.2 (7.5)
Incoming (number)	0.5 (1.7)	2.8 (6.6)	0.9 (3.3)
Births (%)	73 (42)	72 (40)	84 (32)
Purchases (%)	27 (42)	25 (39)	8 (22)
Gifts (%)	0 (3)	3 (15)	7 (22)
Outgoing (number)	1.3 (3.9)	2.0 (7.0)	0.7 (3.6)
Deaths (%)	29 (39)	34 (41)	44 (43)
Sales (%)	40 (42)	39 (42)	22 (35)
On-farm slaughter (%)	27 (37)	25 (38)	25 (40)
Given out (%)	3 (15)	2 (12)	4 (18)
Stolen (%)	1 (8)	NA	0 (0)
Ending stock (number)	1.4 (3.4)	4.6 (6.0)	2.5 (9.1)
Average stock (number)	1.8 (4.0)	5.5 (6.3)	2.4 (8.2)
Change in inventory (%)	–27 (58)	43 (85)	15 (52)
Birth rate (%)[2]	19 (32)	NA	45 (58)
Death rate (%)[3]	32 (71)	17 (35)	28 (90)

1. Flocks dynamics is analysed over one year period and the figures in parentheses are standard deviations.
2. Birth rate is computed as a ratio of the number of lambs born to the number of ewes at the beginning of the year.
3. Death rate is calculated as the ratio of the number of sheep deaths to the average sheep flocks.
Source: Prepared based on ILRI/IFPRI (1999–2000) and CSA (2006).

Table 13. *Goats flocks dynamics[1] under different production systems in Ethiopia*

Flock parameter	Smallholder farmers		Pastoralists
	ILRI/IFPRI data	CSA data	GL-CRSP data
Opening stock (number)	1.5 (4.1)	6.1 (9.1)	4.7 (8.3)
Incoming (number)	0.3 (1.2)	3.2 (4.0)	1.6 (3.1)
Births (%)	83 (34)	79 (36)	86 (31)
Purchases (%)	17 (34)	18 (35)	8 (24)
Gifts (%)	0 (0)	3 (14)	5 (19)
Outgoing (number)	0.6 (1.8)	2.5 (4.3)	1.2 (3.1)
Deaths (%)	23 (36)	41 (42)	52 (42)
Sales (%)	49 (45)	37 (41)	34 (41)
On-farm slaughter (%)	22 (35)	20 (34)	9 (22)
Given out (%)	3 (14)	2 (3)	3 (15)
Stolen (%)	3 (15)	NA	1 (10)
Ending stock (number)	1.20 (3.5)	6.3 (9.3)	5.3 (9.7)
Average stock (number)	1.3 (3.7)	7.4 (9.4)	5.0 (8.9)
Change in inventory (%)	–13 (57)	46 (90)	10 (46)
Birth rate (%)[2]	18 (33)	NA	42 (43)
Death rate (%)[3]	13 (32)	19 (38)	37 (142)

1. Flocks dynamics is analysed over one year period and the figures in parentheses are standard deviations.
2. Birth rate is computed as a ratio of the number of kids born to the number of she-goats at the beginning of the year.
3. Death rate is calculated as the ratio of the number of goat deaths to the average goat flocks.
Source: Prepared based on ILRI/IFPRI (1999–2000) and CSA (2006).

The stocks of sheep and goats at a given point in time and the changes in the flock size due to the inflows and outflows of sheep and goats over one year period are analysed and presented in Tables 12 and 13. The sheep and goat inventories change from year to year. For example, in 1999–2000, the average opening stock of sheep and goats for smallholder farmers is found to be 2.1 and 1.5, respectively. The average number of sheep and goats ending stock is found to be 1.4 and 1.2, respectively. In 1999/2000, on average, there is about 27 and 13% reduction in sheep and goats flock size over one year period. The observed higher change in shoats' inventory indicates that shoats' herds are more dynamic than that of cattle herd. However, in 2004/05 on average, there was about 43 and 46% increase in sheep and goats flock size over one year period.

Similar to cattle, it is observed that births are the most important components of sheep and goats inflows. For both smallholder farmers and pastoralists, the sheep and goats birth account for more than 70% of the inflows to the sheep and goats population. However, compared to cattle, purchases are less important components of the inflows for shoats. Purchase accounts only for about 27 and 17% of the inflows of sheep and goats, respectively, in the case of smallholder farmers and for about 8% of sheep and goat inflows in the case of pastoralists. Thus, for both cattle and shoats, birth is more important than purchase from the market in building and maintaining the size of herd and flocks. McPeak (2001) argued that the high death rate in pastoral area is due to drought.

There are also five components of sheep and goats outflows: deaths, sales, slaughters, gifts and thefts. It is observed that deaths, sales and on-farm slaughters are the major components of sheep and goats outflows. Sheep and goats death over one year period account for about 29 and 23% of sheep and goats outflows, respectively. The sheep and goats sales account for about 40 and 49% of sheep and goats outflows, respectively. Thus, deaths account for significant proportions of sheep and goats outflows, which indicate the high potential of increasing sheep and goats sales just by reducing mortality rates. The size of on-farm shoats slaughters is found to be higher for sheep as compared to goats. The on-farm slaughter account for 27 and 22% of sheep and goats outflows, respectively. These rates are much higher than on-farm slaughter of cattle perhaps because shoats are small animals, which can be consumed by a family when needed but cattle being a larger animal, slaughter for on-farm consumption may be too expensive except by very large families and for exceptional occasions.

Herd size is very important factor in herd accumulation in the pastoral production systems. For example, it is observed that climatic shocks cause a sharp decrease in herd size and accumulation and herd holding recovery after the shock depends on the pre-climatic shock level of herd size (Santos and Barrett 2005). It is argued that in the face of climatic shocks, the cattle holdings of herders with larger herd size recover relatively quickly after the drought

or any climatic shock. In general, in the pastoral production system, herd accumulation is an effective way of reducing risk by the pastoralists (Getachew and McPeak 2004).

Market participation

Livestock producers are classified into four mutually exclusive market participation regimes based on their purchases and/or sales decisions. These market participation regimes include: sales only, purchases only, sales and purchases and neither sales nor purchases. The percentage distribution of livestock producers by different market participation regimes are given in Table 14. Furthermore, for those livestock producers who participate in the livestock market, the frequency distribution of livestock producers by the number of animals sold and/or bought are given in Tables 15–17. It is observed that many smallholder farmers and pastoralists do not participate in the livestock market. Furthermore, for those smallholder farmers and pastoralists who participate in the market, the size of transaction (sale or purchase of cattle or shoats) is found to be very small.

Table 14. *Percentage distribution of livestock producers by market participation regimes, various years*

Market participation regimes	Live animal species		
	Cattle	Sheep	Goats
Smallholder farmers[1]			
Sales only (%)	23	41	37
Purchases only (%)	8	7	6
Sales and purchases (%)	8	3	2
No sales and no purchases (%)	61	49	55
Smallholder farmers[2]			
Sales only (%)	22	26	27
Purchases only (%)	16	23	18
Sales and purchases (%)	12	8	5
No sales and no purchases (%)	50	43	50
Pastoralists[3]			
Sales only (%)	47	18	25
Purchases only (%)	2	6	7
Sales and purchases (%)	4	4	2
No sales and no purchases (%)	47	72	66

1. Prepared based on ILRI/IFPRI (1999–2000).
2. Prepared based on CSA (2006).
3. Prepared based on GL-CRSP (2006).

The number and composition of household annual sales and purchases of cattle are given in Tables 18 and 19, respectively. Oxen and cows account for most of the sales and purchases. The average number of cattle sold was 0.4 and oxen accounted for 56% of the number of cattle sold. The household also purchased on average 0.2 head of cattle of which oxen

accounted for about 53%. Cows accounted for 22 and 15% of cattle sales and purchases, respectively.

Table 15. *Frequency distributions of livestock producers according to the numbers of cattle sold/purchased in Ethiopia, various years*

Number of cattle sold/purchased	Smallholder farmers[1]		Smallholder farmers[2]		Pastoralists[3]	
	Sellers (%)	Buyers (%)	Sellers (%)	Buyers (%)	Sellers (%)	Buyers (%)
1	73	83	73	76	60	38
2	20	12	19	19	20	29
3	4	3	5	3	8	19
≥4	4	2	3	2	12	14
Mean (SD)	1.4 (0.8)	1.2 (0.6)	1.5 (2.5)	1.4 (2.9)	1.8 (1.4)	2.3 (1.6)
Max	6	4	238	240	9	7

1. Prepared based on ILRI/IFPRI (1999–2000).
2. Prepared based on CSA (2006).
3. Prepared based on GL-CRSP (2006).
Figures in parentheses are standard deviations and the minimum size of cattle and shoats owned was zero in all cases.

Table 16. *Frequency distributions of livestock producers according to the numbers of sheep sold/purchased in Ethiopia, various years*

Number of sheep sold/purchased	Smallholder farmers[1]		Smallholder farmers[2]		Pastoralists[3]	
	Sellers (%)	Buyers (%)	Sellers (%)	Buyers (%)	Sellers (%)	Buyers (%)
1	20	49	40	56	52	78
2	26	30	29	25	14	0
3	19	12	13	8	10	11
≥4	35	9	18	11	24	11
Mean (SD)	3.4(3.5)	1.8(1.1)	2.7(8.9)	2.2(9.5)	3.6(4.9)	1.7(1.4)
Max	35	5	506	500	20	5

1. Prepared based on ILRI/IFPRI (1999–2000).
2. Prepared based on CSA (2006).
3. Prepared based on GL-CRSP (2006).
Figures in parentheses are standard deviations and the minimum size of cattle and shoats owned was zero in all cases.

Table 17. *Frequency distributions of livestock producers according to the numbers of goats sold/purchased in Ethiopia, various years*

Number of goats sold/purchased	Smallholder farmers[1]		Smallholder farmers[2]		Pastoralists[3]	
	Sellers (%)	Buyers (%)	Sellers (%)	Buyers (%)	Sellers (%)	Buyers (%)
1	18	63	37	57	38	12
2	33	21	27	25	33	47
3	19	11	14	8	17	23
≥4	30	5	22	10	12	18
Mean (SD)	3.2(2.2)	1.7(1.3)	2.7(2.)	1.9(1.9)	2.0(1.2)	2.5(1.1)
Max	10	6	47	45	6	5

1. Prepared based on ILRI/IFPRI (1999–2000).
2. Prepared based on CSA (2006).
3. Prepared based on GL-CRSP (2006).
Figures in parentheses are standard deviations and the minimum size of cattle and shoats owned was zero in all cases.

Table 18. *Composition of annual number of cattle and shoats sold by households in the highland areas of the three regions of Ethiopia, 1999–2000*

Composition	Amhara	Oromia	Tigray	All
Mean cattle sold	0.4 (0.8)	0.6 (0.9)	0.3 (0.6)	0.4 (0.7)
Oxen (%)	62 (45)	46 (46)	53 (49)	56 (47)
Cows (%)	16 (32)	30 (41)	25 (40)	22 (37)
Bulls (%)	7 (22)	6 (19)	13 (32)	9 (26)
Heifers (%)	7 (22)	13 (32)	9 (25)	9 (25)
Calves (%)	8 (25)	4 (21)	1 (5)	5 (20)
Mean shoats sold	0.8 (2.4)	0.4 (1.0)	0.9 (2.0)	0.8 (2.1)
Sheep (%)	72 (43)	70 (45)	52 (50)	62 (48)
Goats (%)	28 (43)	30 (45)	48 (49)	38 (48)

Note: Figures in parentheses are standard deviations.
Source: Prepared based on ILRI/IFPRI (1999–2000).

Table 19. *Composition of annual number of cattle and shoats purchased by households in the highland areas of the three regions of Ethiopia, 1999–2000*

Animal species purchased	Amhara	Oromia	Tigray	All
Mean cattle purchased	0.2 (0.5)	0.3 (0.7)	0.1 (0.4)	0.2 (0.5)
Oxen (%)	65 (47)	75 (40)	27 (45)	53 (49)
Cows (%)	19 (39)	10 (25)	13 (33)	15 (35)
Bulls (%)	3 (17)	11 (32)	27 (45)	13 (33)
Heifers (%)	10 (29)	4 (13)	29 (44)	15 (35)
Calves (%)	2 (14)	0 (0)	3 (17)	2 (14)
Mean shoats purchased	0.1 (0.6)	0.1 (0.5)	0.2 (0.6)	0.1 (0.6)
Sheep (%)	64 (47)	65 (47)	78 (40)	71 (43)
Goats (%)	36 (47)	35 (47)	22 (40)	29 (43)

Note: Figures in parentheses are standard deviations.
Source: Prepared based on ILRI/IFPRI (1999–2000).

In general, it has been observed that the pastoral households participate in livestock markets but in relatively small volumes and at varying rates over time (Barrett et al. 2004). Barrett et al. (2004) discussed several reasons limiting the market off-take from the pastoral areas. First, there is lack of investment opportunities in the pastoral areas thus making live animal herd building the best investment alternatives. Second, it is observed that most of the producers have limited demand for cash income and because of this they have limited supply response to prices. Furthermore, it is argued that the demand for cash is limited because most of the resources required for livestock production are free, the pastoralists are self-sufficient and there is short supply of consumer goods. As a result, the cash need of pastoralists is usually met by selling of few animals. Other factors observed to limit pastoralists' market participation include: high transaction costs, difficulties in contract enforcement, limited throughput capacity and low and variable producer prices for livestock (Barrett 2001).

Estimating total cattle and shoats supplies for export markets

One of the key questions to be asked in relation to the analysis of live animal supply constraints for export abattoirs is: what would be the quantity of live animal supply for export market after meeting the demand for live animal for domestic consumption? Three main steps are followed in obtaining the estimates of the total cattle and shoats' supplies that would be potentially available for export markets based on the available secondary data. First, the total supplies of cattle and shoats to the domestic and export markets are estimated. Second, the total demands for cattle and shoats for domestic meat consumption are estimated. Finally, the differences between the total cattle and shoats supplies to the domestic and export markets and the total demand for cattle and shoats for domestic meat consumption are used to provide the estimates of the total cattle and shoats available for export markets.[1] The following sections discuss each of these steps in more details.

The estimates of the total supplies of cattle and shoats for the domestic and export markets are obtained by multiplying the appropriate net commercial off-take rates with the available cattle and shoats population estimates obtained from secondary sources. For this study, the population of cattle and shoats were obtained for 2001/02 and 2005/06.

The total cattle, sheep and goat population for sedentary areas by regions in Ethiopia for year 2001/02 were 41.5, 14.7 and 13.6 million heads, respectively (Table 20). Three of the regions of Ethiopia, namely, Oromia, Amhara and SNNPR, jointly account for about 90, 89 and 79% of cattle, sheep and goats, respectively. More than 95% of cattle and shoats are kept in the

1. This estimation approach assumes that the export abattoirs compete in the domestic market for the available live animal supplies. However, the qualities of live animals demanded by the export abattoirs might be different from that of live animals demanded for domestic consumption. Furthermore, this methodology assumes that there are no significant meat imports.

rural areas and the remainder in urban areas. The total cattle, sheep and goats population for sedentary areas in Ethiopia for 2004/05 were 40.4, 20.8 and 16.3 million, respectively (Table 21).

Table 20. *Total livestock population by type and region in Ethiopia excluding and including pastoral areas, 2001/02*

Regions	Cattle			Sheep			Goats		
	Population	% of total	% of urban[a]	Population	% of total	% of urban	Population	% of total	% of urban
Tigray	2,668,078	6.4	1.8	687,212	4.7	2.4	1,759,126	12.9	0.6
Afar	345,635	0.8	2.8	160,385	1.1	5.4	307,456	2.3	5.4
Amhara	10,512,770	25.3	1.5	5,320,330	36.3	1.7	3,815,859	28.0	0.4
Oromia	18,035,686	43.4	2.5	4,691,016	32.0	2.7	4,174,968	30.6	1.8
Somali	512,320	1.2	3.3	454,821	3.1	5.3	574,561	4.2	5.8
Ben-shangul-Gumuz	309,627	0.7	7.4	58,770	0.4	10.6	200,472	1.5	1.6
SNNPR	8,831,450	21.3	1.6	3,169,816	21.6	1.3	2,651,077	19.4	1.2
Gambella	126,198	0.3	8.0	43,746	0.3	2.3	49,076	0.4	4.8
Harari	34,008	0.1	2.7	5,774	0.0	14.3	19,098	0.1	6.5
Addis Ababa	97,215	0.2	32.0	29,682	0.2	58.1	18,861	b	b
Dire Dawa	54,155	0.1	6.4	34,015	0.2	14.9	91,007	0.7	7.1
$Total_1$	41,527,142	100.0	2.1	14,655,567	100.0	2.3	13,642,700	100.0	1.4
$Total_2$	51,908,927	–	–	24,425,945	–	–	22,737,833		

a. In general, urban centre is defined as a locality with 2000 or more inhabitants (CSA 2001).
b. Actual figures are not specified due to high CV and insignificant holdings. $Total_1$ is total population of cattle, sheep and goats for sedentary areas of Ethiopia while $Total_2$ includes pastoral areas as well.
Source: CSA (2003).

The pastoral areas in Ethiopia also account for significant proportions of the total livestock production and the total supply of live animals to the domestic and export markets. The pastoral areas cover about 625 thousand km^2 in 7 regional states and 122 districts (Table 22). However, the data on the cattle and shoats population in the pastoral areas is very scarce. Some available rough estimate indicates that the pastoral areas account for about 20% of cattle, 40% of sheep and 40% of goat population in the country (Belachew Hurissa, personal communication, 2007).

Table 21. *Total livestock population by type and region in Ethiopia excluding and including pastoral areas, 2004/05*

Region	Livestock species					
	Cattle	%	Sheep	%	Goats	%
Tigray	2,662,166	6.6	813,546	3.9	2,399,808	14.7
Afar	317,108	0.8	156,880	0.8	411,047	2.5
Amhara	10,077,301	24.9	7,530,518	36.3	4,856,472	29.8
Oromia	18,247,970	45.1	8,084,573	38.9	5,383,640	33.0
Somali	520,902	1.3	594,289	2.9	668,619	4.1
Benshangul-Gumuz	350,390	0.9	68,931	0.3	314,277	1.9
SNNPR	8,043,173	19.9	3,403,098	16.4	2,054,080	12.6
Gambella	126,198	0.3	43,746	0.2	49,076	0.3
Harari	37,395	0.1	4501	0.0	32,782	0.2
Addis Ababa	26,266	0.1	11,052	0.1	4,079	0.0
Dire Dawa	38,439	0.1	54,173	0.3	124,094	0.8
$Total_1$	40,447,308	100.0	20,765,307	100.0	16,297,974	100.0
$Total_2$	50,559,135		34,608,845		27,163,290	

Note: $Total_1$ is total population of cattle, sheep and goats for sedentary areas of Ethiopia while $Total_2$ includes pastoral areas as well.
Source: CSA (2006).

Table 22. *Pastoral areas, districts, human population and livestock density*

Region	Total surface of the region (km^2)	Pastoral areas only (km^2)	Number of pastoral districts	Human population of 122 pastoral districts	Livestock of 122 pastoral districts (TLU)[1]
Afar	90,400	90,400	29	1,301,000	621,700
Benshangul-Gumuz	48,290	8410	3	40,640	10,100
Dire Dawa	1200	1200	1	108,570	39,200
Gambella	25,800	17,330	5	133,600	288,900
Oromia	353,000	152,070	34	4,007,950	4,996,300
SNNPR	112,340	30,370	6	219,670	693,900
Somali	325,070	325,070	44	4,002,170	2,533,300
Total	956,030	624,880	122	9,813,600	9,183,500

1. TLU = Tropical livestock unit. One TLU is equivalent to 250 kg live weight.
Source: Adapted from MoARD (2004).

Based on these assumptions, the total estimated cattle, sheep and goat population in 2001/02 in Ethiopia including the pastoral areas are 51.9, 24.4 and 22.7 million, respectively and in 2005/06 these figures were 50.1, 34.6 and 27.2 million, respectively. Thus, between the two periods cattle population decreased by 1.8 million (3%) and sheep and goat population increased by 10.2 million (42%) and 4.5 million (20%), respectively.

Once the estimates of the total population of cattle and shoats are obtained, the next step is to estimate the total market supply. In order to compute the total market supply from highland and sedentary areas of lowland Ethiopia, we used the net commercial off-take rates obtained from ILRI/IFPRI dataset while the net commercial off-take rate obtained from the GL-CRSP dataset is used to compute the total market supply of cattle and shoats from the pastoral areas.[2] Accordingly, the total market supply of cattle, sheep and goats from the highland and sedentary areas of Ethiopia in 2001/02 are estimated to be 3.3, 3.2 and 2.5 million, respectively. On the other hand, the total market supply for cattle, sheep and goats from the pastoral areas of Ethiopia for the same year are estimated at 0.9, 0.6 and 0.6 million, respectively. When both the sedentary and pastoral areas are combined, the total market supplies of cattle, sheep and goats in 2001/02 are estimated at 4.2, 3.8 and 3.1 million, respectively and for 2005/06 they are estimated at 4.1, 5.4 and 3.7 million, respectively. The available secondary data did not allow us to further disaggregate cattle and shoats supplies by different quality dimensions, for example, by age and weight.

Finally, the residual total supply of live animals for export markets (live and meat) is obtained by subtracting the total live animal equivalents for domestic consumption from the total live animals supply to the market. Three main steps are followed in estimating the off-take rates of cattle, sheep and goats for domestic consumption. First, the human population projections for Ethiopia for different years based on the human population census data for 1994 are obtained (Table 23). Based on this, the total human population of Ethiopia is estimated at 62,583,000 for 1999/2000, 66,282,000 for 2001/02 and 74,055,500 for 2005/06.

Table 23. *Projected total, urban and rural population size in Ethiopia (1995–2007)*

Year	Population ($\times 10^3$)		
	Urban	Rural	Total
1995	7587	47,062	54,649
1996	7950	48,422	56,372
1997	8315	49,802	58,117
1998	8691	51,191	59,882
1999	9074	52,598	61,672
2000	9473	54,022	63,495
2001	9886	55,458	65,344
2002	10,307	56,913	67,220
2003	10,745	58,382	69,127
2004	11,199	59,867	71,066
2005	11,675	61,369	73,044
2006	12,172	62,895	75,067
2007	12,689	64,438	77,127

Source: Projected from 1994 population census (CSA 1998).

2. The net commercial off-take rates based on CSA dataset for 2004–05 are considerably low and as a result they were not used in computing the livestock supply.

Second, the total quantities of beef, mutton and goat meat consumed in 1999/2000 are obtained by multiplying the average per capita consumption of beef, mutton and goat meat for 1999/2000 by the human population for 1999/2000. The per capita beef, mutton and goat meat consumption for rural and urban areas are given in Table 24.

Table 24. *Annual per capita consumption of beef, mutton and goat meat in Ethiopia in 1999/2000 (kg/capita per year)*

Regions	Rural			Urban		
	Beef	Mutton	Goat meat	Beef	Mutton	Goat meat
Tigray	2.04 (5.04)	0.27 (1.2.20)	0.30 (2.49)	6.10 (21.99)	1.36 (6.63)	1.08 (21.15)
Afar	0.43 (3.83)	0.22 (2.09)	0.12 (1.08)	0.72 (3.66)	5.31 (20.90)	3.35 (11.85)
Amhara	1.43 (5.83)	0.59 (4.90)	0.47 (4.02)	7.69 (38.07)	7.27 (47.07)	0.87 (6.53)
Oromia	1.87 (6.91)	0.44 (3.87)	0.41 (3.74)	6.22 (27.32)	1.36 (9.69)	0.51 (4.95)
Somali	0.10 (0.58)	0.13 (1.47)	0.48 (3.05)	6.62 (36.40)	0.08 (0.70)	1.46 (11.01)
Benshangul-Gumuz	2.76 (7.49)	0.27 (3.15)	0.73 (4.07)	9.86 (35.24)	0.86 (7.21)	0.39 (2.68)
SNNPR	1.89 (7.27)	0.42 (3.02)	0.15 (1.46)	4.52 (19.67)	0.66 (4.06)	0.22 (2.21)
Gambella	1.06 (4.98)	0.25 (2.34)	0.09 (1.16)	14.14 (56.30)	0.55 (6.50)	0.26 (2.92)
Harari	0.76 (5.38)	0.002 (0.03)	0.07 (0.51)	5.89 (26.84)	0.02 (0.24)	0.36 (2.56)
Addis Ababa	4.98 (14.04)	0.51 (3.19)	0.23 (2.49)	7.24 (18.49)	1.98 (15.70)	0.03 (0.67)
Dire Dawa	0.12 (0.93)	0.15 (2.06)	0.27 (2.53)	11.56 (64.55)	0.27 (5.65)	2.71 (18.63)
All	1.67 (6.62)	0.39 (3.44)	0.33 (3.01)	7.04 (33.00)	2.41 (22.38)	0.81 (9.12)

Note: Figures in parentheses are standard deviations.
Source: Estimated based on CSA household consumption and expenditure survey in 1999/2000.

Third, the estimates of total cattle, sheep and goat equivalents of different classes of meat consumed in the rural and urban areas for different years are obtained by converting the estimated total quantity of beef, mutton and goat meat consumed in a given year into live animal equivalents using appropriate conversion factors. Conversion factors used are based on dressing weights obtained from Domestic Animal Genetic Resource Information System (DAGRIS 2006) and are presented in Table 25. For example, based on this the total live animal equivalents (heads) consumed for cattle, sheep and goats in 2001/02 are 1.3, 4.0 and 2.3 million heads, respectively. Similarly, the total cattle, sheep and goats equivalents consumed in 2005/06 are 1.5, 4.6 and 2.7 million, respectively (Table 26).

Table 25. *Dressing percentages and net weight by animal species*

Species	Dressing percentage (%)	Gross weight (kg)	Net weight (kg)
Cattle	52	250	130
Shoats	46	25	11.5

Source: DAGRIS (2006).

The domestic live animal consumption off-take rate is obtained by dividing the total live animal equivalents consumed by the total live animal population estimated for that year. Thus, for example, the estimated national off-take of cattle, sheep and goat for domestic consumption in 2001/02 is 2.5, 16 and 10%, respectively, and in 2005/06 is 3, 13 and 10%, respectively (Table 26). Consumption of cattle and sheep is almost equally split between rural and urban areas. On the other hand, a significantly higher proportion of domestic consumption of goat occurs in the rural areas. Thus, when these consumption off-take rates are compared with the estimated off-take rates from production systems, it appears that domestic consumption absorbs a large share of the overall low net commercial off-take rates or market supply from smallholder farmers and pastoralists leaving a small share for the live animal and meat export activities, especially for shoats.

Once the estimates for the total live animals supply to the market and the demand for live animals for domestic consumptions are obtained, the total supply of live animals for export markets is obtained by subtracting the total live animal equivalents for domestic consumption from the total live animals supply to the market. For example, in 2005/06 the total supply of cattle, sheep and goats to the export markets after meeting domestic consumption demand are 2.6, 0.8 and 1.0 million, respectively. For these quantities, the meat export abattoirs have to compete with formal and informal live animal exports. However, these figures are only rough estimates based on available secondary data. If the assumptions on the population and income growth, per capita domestic consumption and off-take rates change, then different set of supply estimates could be obtained.

It is observed that there are significant off-take of cattle and shoats for domestic consumption given the observed low net commercial off-take rates. For example, the domestic consumption off-take rate for cattle, sheep and goats in 2005/06 for Ethiopia was 3, 13 and 10%, respectively. In the short run, there might be some degree of market segmentation regarding the demand for live animals due to different quality requirements for the domestic consumption and export markets. However, in the long run, with growing supermarkets and increased demand for high quality meat as a result of the increase in the income of consumers, the demand for high quality live animals for domestic consumption is expected to increase, which increases the competitive pressure on export abattoirs.

Table 26. *Live animal off-take rates for domestic consumption in 2001/02 and 2005/06*

Classes of meat/ live animals	Income elasticity of demand[1]	Base year (1999–2000) consumption of meat (t)	2001/02			2005/06		
			Total quantity of meat consumed (t)[2]	Total live animals equivalent consumed (head)	Live animal off-take rates for domestic consumption (%)[3]	Total quantity of meat consumed (t)	Total live animals equivalent consumed (head)	Live animal off-take rates for domestic consumption (%)
Rural								
Beef/cattle	0.73	89,028	96,950	745,767	1.44	114,971	884,395	1.75
Mutton/sheep	0.30	20,791	22,218	1,931,960	7.89	25,371	2,206,192	6.36
Goat meat/goat	0.30	17,592	18,799	1,634,735	7.18	21,468	1,866,778	6.86
Urban								
Beef/cattle	0.68	65,285	70,940	545,689	1.05	83,759	644,302	1.27
Mutton/sheep	0.27	22,349	23,851	2,074,009	8.47	27,165	2,362,142	6.81
Goat meat/goat	0.27	7512	8016	697,074	3.06	9130	793,915	2.92
Country								
Beef/cattle	0.66	154,313	167,889	1,291,457	2.49	198,731	1,528,697	3.02
Mutton/sheep	0.27	43,140	46,069	4,005,969	16.37	52,536	4,568,335	13.17
Goat meat/goat	0.27	25,104	26,816	2,331,809	10.23	30,598	2,660,693	9.78

1. Income elasticities of demand for various meat groups are computed by IFPRI-Ethiopia based on CSA consumption and expenditure survey data in 1999/2000 (Kassu Wamisho and Alemayehu Seyoum, personal communications, 2007).
2. Total quantities of meat consumed in 2001/02 and 2005/06 were computed using the formula: $D_t = D_0 * (1 + \beta + \mu * y)^t$ where D_t is the projected quantity of meat consumption in period *t*, D_0 is the base year meat consumption in 1999/2000, β is annual rate of change in population and assumed to be 2.69%, μ is income elasticity of demand for meat, and y is the annual rate of change in income assumed to be 2.28% based on the five years average of real GNP per capita growth for the period from 1999/2000 to 2004/05.
3. Domestic consumption off-take rate of live animal was computed by dividing the total live animal equivalents of meat consumed in one year by the estimated live animal population for that year.
Source: Based on CSA (1999/2000).

4.2 Results of the econometric analysis

The econometric analysis is made using the ILRI/IFPRI dataset. The descriptive statistics of the variables included in the various regression analyses is given in Table 27.

Table 27. *Summary statistics of variables included in the regression analysis*

Variables	Region			Whole sample
	Amhara	Oromia	Tigray	
Male household head dummy	0.93 (0.26)	0.90 (0.30)	0.85 (0.36)	0.89 (0.32)
Age of household head (years)	41.21 (12.82)	51.46 (14.31)	46.07 (13.57)	44.70 (13.77)
Education of household head (years of schooling)	2.59 (2.99)	2.77 (2.95)	1.37 (1.94)	2.05 (2.62)
Number of household members	6.72 (2.49)	7.75 (2.80)	6.50 (2.28)	6.75 (2.47)
Number of children less than 15 years old	3.43 (1.69)	2.13 (1.46)	3.34 (1.90)	3.23 (1.81)
Tropical livestock unit (TLU)	3.87 (2.92)	6.47 (4.40)	4.46 (2.89)	4.46 (3.22)
Total land holding (ha)	1.64 (1.27)	2.16 (1.18)	1.23 (0.92)	1.51 (1.15)
Private grazing land area (ha)	0.01 (0.05)	0.06 (0.26)	0.03 (0.13)	0.02 (0.13)
Communal grazing land area (ha)	24.05 (64.13)	143.25 (204.16)	2.54 (8.61)	28.87 (93.75)
Total crop income (ETB)	495.20 (722.48)	977.40 (797.12)	191.02 (319.47)	414.94 (637.85)
Total livestock product income (ETB)	44.01 (111.03)	70.77 (192.80)	97.45 (191.20)	71.85 (164.55)
Off-farm income (ETB)	384.11 (669.68)	493.53 (805.52)	662.24 (1034.2)	525.34 (879.71)
Livestock expenditures (ETB)	327.47 (379.90)	152.19 (368.14)	168.59 (221.10)	232.78 (324.86)
Membership in *kebele* administration dummy	0.81 (0.39)	0.11 (0.31)	0.02 (0.13)	0.36 (0.48)
Walking distance to veterinary clinic (minutes)	122.65 (86.35)	122.15 (83.34)	124.98 (92.99)	122.45 (86.35)
Weighted average cattle prices (ETB)[1]	547.92 (159.45)	676.26 (232.63)	559.89 (134.74)	569.25 (164.88)
Weighted average shoats prices (ETB)[1]	81.08 (25.17)	97.00 (56.62)	67.44 (15.08)	76.31 (28.97)
N	369	109	406	884

1. Weighted average cattle price is computed by summing prices of oxen and cow sold weighted by their proportion sold and similarly the weighted shoats price is computed by summing the prices of sheep and goats sold weighted by the proportion of sheep and goats sold.
Figures in parentheses are standard deviations.

More than 80% of the heads of the farm households are males. The average age of household head is about 45 years. The household head has an average of two years of schooling. The average household size is about 7 people, the number of children less than 15 years old being about 3. The average herd/flock size is about 4.46 tropical livestock unit (TLU), the highest average TLU of 6.47 is observed for Oromia while the lowest TLU of 3.87 is observed for the Amhara region. In terms of the total land holdings, the average area is 1.51 ha. The use of private grazing areas is very limited. The average communal grazing areas to which the households have access is about 29 ha. Both private and communal grazing areas are the smallest for Tigray region. The average crop income of household is about Ethiopian birr (ETB)[3] 415 per year while livestock product income is about ETB 72 per year. The highest total livestock product income of ETB 97 is observed for Tigray region. The average off-farm income is ETB 525 per annum. The off-farm income is also found to be the highest for Tigray region. The average household expenditure on livestock is ETB 233, the highest is observed for Amhara region. More than 80% of households in Amhara region are members of *kebele* administration while only very few of them are observed to be a member of *kebele* administration in Oromia and Tigray regions.

The results of multinomial logit regression estimation of household discrete-choice market participation decision for cattle and shoats are given in Tables 28 and 29, respectively.[4] For the estimation purpose, the base category used is non-market participation regime. Thus, the multinomial logistic regression assesses the effects of various independent variables on the odds of various market participation regimes vs. not participating in the market. The model chi-square indicates that the overall goodness of fit of the model is statistically significant at a probability of less than 1% for both cattle and shoats. Furthermore, the Hausman specification test fails to reject the null hypothesis of the independence of irrelevant alternatives.

It can be seen from Table 28 that the main factors influencing the household's discrete-choice of cattle market participation decision are the total livestock owned as measured by tropical livestock unit (TLU) and landholdings. The TLU is positively associated with household's participation in cattle market as a seller only and both as a seller and buyer. As the TLU increases, the probability that the household participate in cattle market as a seller only increases while the probability of non-participation in cattle market decreases (see Figure 1). Households with larger herd size have higher ability to generate surplus animals and are therefore more likely to sell.

3. Ethiopian birr (ETB). In April 2008, USD 1 = ETB 9.4916.
4. STATA 9 is used in the multinomial logistic regression estimation.

Table 28. *Results of multinomial logit estimation for cattle*

Variables	Market participation regimes[1]		
	Only sell	Only buy	Both sell and buy
Sex (1 = male, 0 = female)	0.211(0.272)	1.084(0.548) **	1.363(0.617) **
Age (years)	0.003(0.007)	0.002(0.011)	–0.022(0.011) *
Schooling (years)	0.021(0.033)	0.019(0.049)	0.044(0.047)
Size of household	–0.060(0.059)	0.131(0.080)	0.065(0.079)
Children ≤15 years old (number)	0.143(0.075) *	–0.082(0.103)	–0.088(0.102)
Tropical livestock unit (TLU)	0.267(0.034)***	0.037(0.051)	0.212(0.047) ***
Land holding (ha)	–0.219(0.104)**	0.318(0.103)***	–0.027(0.132)
Communal grazing land (ha)	0.001(0.001)	–0.002(0.002)	0.002(0.001)
Crop income (ETB)	–0.000(0.000)	0.000(0.000)	0.000(0.000)
Livestock product income (ETB)	0.000(0.000)	–0.002(0.001)	–0.000(0.001)
Off-farm income (ETB)	–0.000(0.000)	0.000(0.000) **	0.000(0.000)
Weighted price of cattle	–0.000(0.001)	–0.001(0.001)	0.001(0.001)
Weighted price of sheep	–0.003(0.003)	0.000(0.006)	–0.006(0.005)
Amhara[2]	0.637(0.200) ***	0.046(0.313)	0.988(0.317) ***
Oromia	0.711(0.376) *	0.139(0.546)	1.027(0.493) **
Constant	–2.358(0.512) ***	–4.334(0.881) ***	–4.108(0.876) ***
N	1054		
McFadden's R^2	0.057		
Cragg-Uhler R^2	0.213		
Model Chi-square	210.94		
Significance level	0.000		

1. Base category is neither sell nor buy regime.
2. Tigray is the omitted regional dummy variable.
***, **, * indicate statistical significance at a probability of less than 1, 5 and 10%, respectively. Figures in parentheses are standard errors.
Source: Based on ILRI–IFPRI (1999/2000).

There is a statistically significant negative effect of land holding on the household decision to participate in cattle market as a seller only while its effects on household decision to participate in cattle market as a buyer only is positive and statistically significant. As the size of land holdings increases, the probability that the household participate in cattle market as a buyer only increases while the probability of non-participation in cattle market decreases (Figure 2). This may be due to the fact that as the land size increases the farm households need more cattle for draught purpose instead of selling it in the market. The other interpretation for negative relationship between landholdings and the decision to participate as a seller only could be that landholding is an indicator for wealth. The more land the farm

households own the more wealthy is the household and the less is the need to sell cattle to generate income. Wealthy households might have other sources of income, which decrease their need to sell cattle.

Table 29. *Results of multinomial logit estimation for shoats*

Variables	Market participation regimes[1]		
	Only sell	Only buy	Both sell and buy
Sex (1 = male, 0 = female)	0.340(0.252)	0.073(0.432)	0.461(1.113)
Age (years)	–0.011(0.007)	–0.019(0.013)	–0001(0.026)
Schooling (years)	0.004(0.032)	–0.105(0.070)	0.112(0.091)
Size of household	0.102(0.054) *	–0.069(0.104)	0.200(0.173)
Children ≤15 years old (number)	0.051(0.066)	0.088(0.128)	–0.290(0.246)
Tropical livestock unit (TLU)	0.132(0.030) ***	0.070(0.050)	0.053(0.105)
Land holding (ha)	–0.211(0.098) **	0.072(0.136)	0.013(0.332)
Communal grazing land (ha)	0.000(0.001)	0.004(0.002) **	0.001(0.003)
Crop income (ETB)	–0.000(0.000) **	0.001(0.000) ***	0.001(0.001)
Livestock product income (ETB)	0.002(0.001) ***	0.002(0.001) ***	0.003(0.001) **
Off-farm income (ETB)	0.000(0.000)	–0.000(0.000)	–0.002(0.001) *
Weighted price of cattle	0.0003(0.001)	–0.001(0.001)	–0.002(0.002)
Weighted price of shoats	–0.009(0.003)***	–0.011(0.006) **	–0.060(0.020) ***
Amhara[2]	0.228(0.185)	–0.676(0.367)**	–0.056(0.723)
Oromia	0.194(0.363)	–0.962(0.667)	0.250(1.118)
Constant	–1.654(0.470)***	–0.808(0.882)	–0.097(2.122)
N	1054		
McFadden's R^2	0.030		
Cragg-Uhler R^2	0.163		
Log likelihood	–750.040		
Model Chi-square	145.40		
Significance level	0.088		

1. Base category is neither sell nor buy regime.
2. Tigray is the omitted regional dummy variable.
***, **, * indicate statistical significance at a probability of less than 1, 5 and 10%, respectively. Figures in parentheses are standard errors.
Source: Based on ILRI–IFPRI (1999/2000).

It is observed that male-headed households are more likely to participate in cattle market both as buyer only and as a seller and a buyer as compared to female-headed households. Off-farm income is observed to be positively associated with the household's participation in cattle market as a buyer only indicating the importance of off-farm income to farm

households in building livestock assets. It is also observed that there is significant regional variation in household's participation in cattle market in that the households in Oromia and Amhara regions are more likely to participate in the cattle market as compared to households in Tigray region. It is interesting to note that the effects of cattle and shoats prices are not significant indicating that prices are not important factor in the household's discrete-choice market participation decision in the cattle market. The negative and statistically significant coefficients on constant terms indicate that there are other variables, which decrease the likelihood of household participation in cattle market but, which are not accounted for in our analysis.

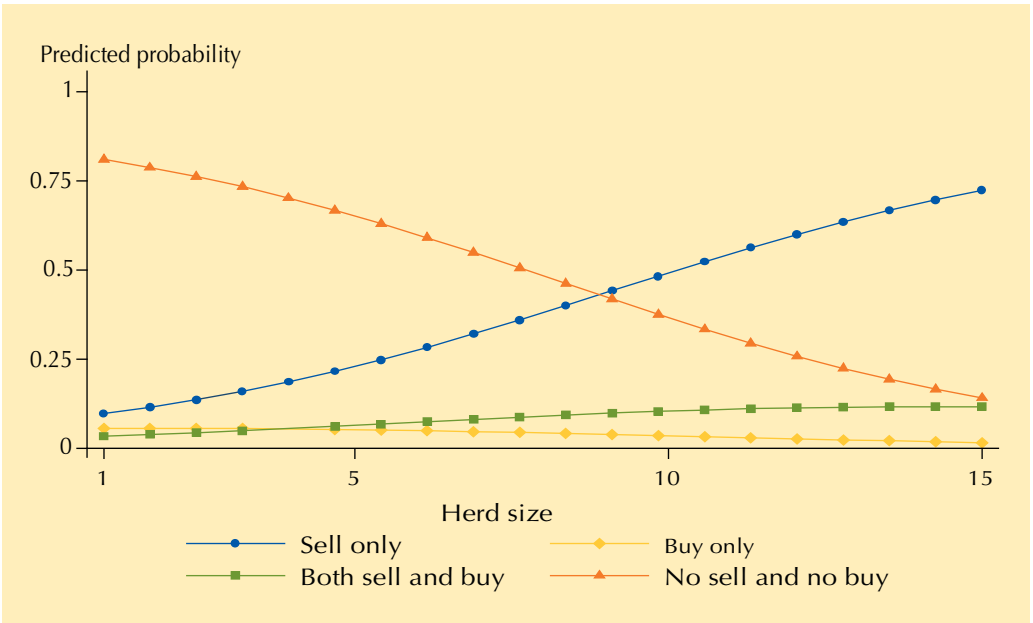

Figure 1. *Changes in cattle market regime probabilities as TLU changes*.

The results of econometric analysis for shoats are presented in Table 29. Similar to the results for cattle, the main factors influencing the household's discrete-choice decision to participate in shoats market are TLU and landholdings. The TLU is positively associated with household's participation in shoats market as a seller only. As the TLU increases, the probability that the household participate in shoats market as a seller only increases while the probability of non-participation in shoats market decreases (Figure 3). However, the effect of TLU on the other market participation regimes is found to be not significant. The effect of land holding is found to be negative and significant only in the case of market participation as a seller only. As the size of land holding increases, the probability that the household participate in shoats market

as a seller decreases (Figure 4). This may reflect the fact that farm households with sufficiently large land holdings give priority to crop and cattle production.

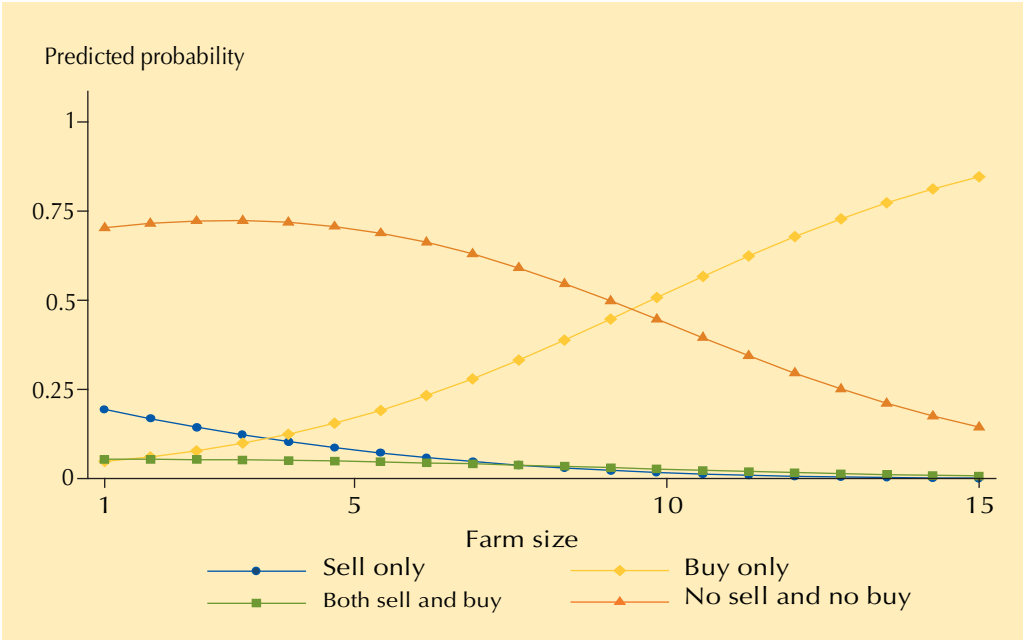

Figure 2. *Changes in cattle market regime probabilities as farm size changes.*

There are statistically significant effects of crop income on the households' participation in shoats market as a seller only and buyer only. The crop income decreases the likelihood of household to participate in the shoats market as a seller only, reflecting the fact that households who are engaged more in crops are less active in market-oriented shoat production. The crop income also increases the likelihood of households to participate in shoats market as a buyer only, which may be explained by higher cash availability. There is statistically significant negative price effect on shoat's market participation in all cases. This indicates that, contrary to the cattle market, in the shoats' market price is an important factor in the household's decision to participate in the market. Negative response to price on the probability to sell may indicate that when prices are higher, fewer sales may generate needed revenue for family cash needs.

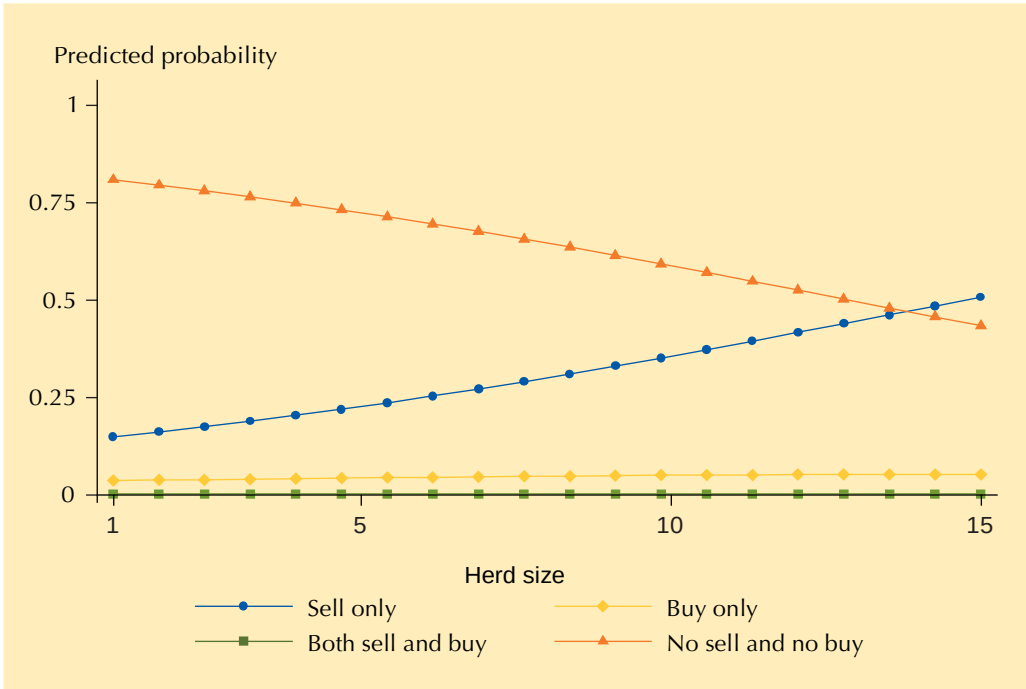

Figure 3. *Changes in shoats market regime probabilities as TLU changes.*

Figure 4. *Changes in shoats market regime probabilities as farm size changes.*

5 Conclusion and recommendations

The main objective of this study was to assess the current off-take rates for cattle and shoats in the highland and pastoral areas of Ethiopia. Both descriptive and econometric analyses are made using secondary data obtained from different sources. Several significant conclusions are drawn from the analyses, which may provide useful insights towards the designing and implementation of strategies to alleviate the shortage of quality live animal supply in the market.

It is observed that smallholder farmers and pastoralists have limited livestock holdings and limited market participation. The implication of limited livestock holdings and limited market participation is that under the current production and marketing conditions small-scale farmers and pastoral livestock production systems do not provide regular and adequate supply of quality live animals to the market, which adversely affect the efficient utilization of meat processing capacity of the existing export abattoirs. Furthermore, this result also indicate that the plan for the establishment of new export abattoirs in different parts of the country has to proceed with great caution and careful assessment of the availability of live animals suitable for export abattoirs.

It appears that in response to the emerging market opportunities, the capacities and methods of livestock production and marketing practices of smallholder farmers and pastoralists and agricultural extension services have changed very little. Therefore, in order to take advantage of the emerging export market opportunities, there is a need to explore different alternative strategies of increasing the supply of quality live animals for export abattoirs. The social and economic feasibilities of alternative strategies need to be carefully evaluated and there is a need to identify and assess on ways how to effectively and efficiently integrate smallholder farmers and pastoralists to the high value domestic and export markets value chains for live animals and meat through the development of appropriate institutions, policies and marketing infrastructure and support services. This requires detailed study of domestic and export market live animals and meat value chains in order to identify the constraints and opportunities to improve the supply of quality live animals.

While much improvement has been achieved in crop production practices due to new and improved crop extension approaches, livestock extension remains very poor. Given the importance of livestock in the livelihood of smallholder households in several ways and given the importance of livestock in national output and income generation, strategic improvement of extension delivery is essential to improve productivity and quality of animals and market orientation of smallholder producers. Along with dissemination of technology for better feeding and health management practices, educating farmers about the benefits

and the desirability of selling animals at optimal age and weight will be necessary to significantly increase the quantity and quality of off-take. This is not the responsibility of public sector only. If abattoirs are interested in the regular supply of better quality animals by smallholders and pastoralists, they should be active partners in this strategy. Use of contracts as an instrument will provide the scope for the application of such extension and informal education strategy to induce change in the production and marketing behaviour of smallholders and pastoralists.

In the long run, specialized ranches and feedlots may be developed by abattoirs or others interested in commercial livestock production for producing quality animals in large numbers. But these need not necessarily be self-contained enterprises doing everything from breeding to finishing. Rather large number of smallholder farmers and pastoralists can be linked with such enterprises as supply sources of young animals for fattening provided attractive prices are paid to smallholders to encourage them to get into such activities as income generating businesses. Research is required in the area of feedlot development in Ethiopia and on how to incorporate smallholder farmers and pastoralists into the feedlot operations.

There is lack of reliable baseline data to support the business and policy decision making in the livestock subsector in Ethiopia. For example, adequate information on what is demanded in the domestic and export markets and the production and marketing practices of livestock producers in different production systems is lacking. Even export statistics are not recorded and managed in ways to allow accurate aggregation and quick analysis to support private business and public policy decision making. For the purpose of monitoring the dynamics of livestock production and marketing there is a need for regular collection of production and marketing data and their dissemination in user friendly format.

Analysis of the detailed cost structure of export abattoirs, their procurement mechanisms and procurement areas was not within the scope of this research. However, it is very important that the export abattoirs examine their operational efficiency, cost structures and develop sound procurement policies and practices to improve their overall efficiency rather than just concentrating on the supply side constraints. In the future, detailed study of cost structure for export abattoirs and a detailed analysis of the current livestock value chains will be required to identify entry points to increase purchase of animals and reduce costs of operation.

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Appendix 1: Summaries of data sources, weaknesses and strengths

Dataset used	Strengths	Weaknesses
ILRI/IFPRI household surveys Reference year: 1999–2000 Coverage: Highlands of Amhara, Tigray and Oromia Sample size: 1054	–Samples drawn based on multi-stage stratified sampling technique –Contains livestock inventory data, which allows the descriptive and econometric analyses	–The survey was only for three highland regions of Ethiopia and did not cover the lowlands –The dataset is more than six years old but it is the latest dataset that could allow useful econometric analysis
CSA livestock survey Reference year: 2004–2005 Coverage: Highlands and sedentary lowlands Sample size: 458,557	–Covers most regions of Ethiopia except pastoral lowland areas –Large sample size –Contains livestock inventory data to analyse off-take rates –Most recent dataset	Pure pastoral areas are not covered in the survey It does not include relevant variables that can affect off-take rates hence not possible to conduct econometric analysis
GL-CRSP baseline household survey Reference year: 2003–2005 Coverage: Borana pastoral households Sample size: 451	–Fills the gap where information on pure pastoral areas was lacking –Panel data for three consecutive years –Most recent dataset	–It only covered the Borana pastoral areas and have limited area coverage –Dataset accessed did not have other relevant variables, which allow econometric analysis
CSA household expenditure and consumption survey Reference year: 1999–2000 Coverage: Highlands and sedentary lowlands Sample size: 17,334	–Relatively recent dataset available on meat and other consumption in Ethiopia –The dataset allows to calculate per capita consumption of various meat groups	–The dataset is about six years old. The survey has been repeated recently, but it was not yet available at the time of this analysis

Appendix 2: Specification of multinomial logit model

The specification of multinomial logit probability model for farm household's market participation regime following Wooldridge (2002) is given below. First, let j denotes a given discrete market participation regime for farm households, which takes the values from 0 to 3 whereby: j = 0 (no market participation regime) represents households who neither sell nor buy; j = 1 represents households who only sell; j = 2 represents households who only buy; j = 3 represents households who both sell and buy. Then, choosing the j = 0 as standard or base market participation regime and assuming that the sum total of probabilities of all the four market participation regimes must be unity, the logistic probability functions for the four market participation regimes are given as follows:

In general, the multinomial logit model is considered as a simultaneous estimation of binary

$$(2.1)\ P_0(j=0\mid x)=\frac{1}{1+e\sum_{j=1}^{3}e^{\beta_j x}}$$

$$(2.2)\ P_1(j=1\mid x)=\frac{e^{\beta_1 x}}{1+\sum_{j=1}^{3}e^{\beta_j x}}$$

$$(2.3)\ P_2(j=2\mid x)=\frac{e^{\beta_2 x}}{1+\sum_{j=1}^{3}e^{\beta_j x}}$$

$$(2.4)\ P_3(j=3\mid x)=\frac{e^{\beta_3 x}}{1+\sum_{j=1}^{3}e^{\beta_j x}}$$

logit model for all possible comparisons among alternatives. In our case, with four market participation regimes, we simultaneously estimate three binary logits, which are given as follows:

$$(2.5)\ \ln\Omega_{j/0}(x)=\ln\left(\frac{p_j(J=j\mid x)}{p_0(J=0\mid x)}\right)=x\beta_{j/0},\quad for\ \ j=1\ to\ 3$$

where, ln $\Omega_{j/0}$ (x) is the natural log of odds ratio of a market participation regime *j* relative to the base participation regime (*j = 0*), x is a vector of independent variables and is a vector of parameters to be estimated for different market participation regimes. In the above formulations, the other three market participation regimes are compared with the no market participation regime. The dependent variable in the logit model is the log of the odds of a

given market participation regime to the standard market participation regime. The logit estimate allows the analysis of the effects of independent variables on the odds and the probabilities of different market participation regimes.

The likelihood function for logit model is given as a product of the above four probability density functions as follows:

$$(2.6)\ L(\beta_1, \beta_2, \beta_3 \mid x) = \prod_{i=1}^{N} p_j,\ for\ j = 0,1,2,3$$

where, N is the sample size, p_j is the probability density function for j^{th} market participation regime, and β_1, β_2 and β_3 are parameter estimates to be estimated by using the maximum likelihood estimation method. One of the problems in the multinomial logit model is the problem of IIA. However, in our case since the four market participation regimes are mutually exclusive the problem of independence of IIA does not arise.

There are two important ways in which the effects of the independent variables are interpreted. The first is the effect of the independent variables on the probability of the different market participation regimes. This is given as:

$$(2.7)\ \frac{\partial\ pr(J = j \mid x)}{\partial\ x_k} = p_j(J = j \mid x)\left[\beta_{kj} - \sum_{j=1}^{3} \beta_{kj}\, p_j(J = j \mid x)\right]$$

The second is the effect of a given independent variable on the odds ratio. This is how a given variable affect the odds of a household choosing a given market participation regime relative to the base or standard market participation regime. This is obtained by taking the partial derivatives of the odds ratio with respect to a given variable and is given by $_j$. In addition, the effect of variable x_i on the market participation regime for $j = 2$ relative to the market participation regime $j = 1$ where the base market participation regime is $j = 0$ is given as:

$$(2.8)\ \frac{\partial \ln \Omega_{2/1} \mid x}{\partial\ x_i} = \beta_2 - \beta_1$$

If none of the independent variables affects the odds outcome 2 relative to outcome 1, we say that outcome 2 and 1 are indistinguishable with respect to the variables in the model. The effect of a given independent variable on the market participation regime is conducted using the likelihood ratio test. The null hypothesis is that all the parameter estimates associated with a given variable for all regimes are jointly zero; the rejection of the null hypothesis indicates that a given variable does not have effect on the farm household choice of market participation regime.

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